Annual Report of Accomplishments and Results
October 1, 2001 to September 30, 2002

NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION

COLLEGE OF LIFE SCIENCES AND AGRICULTURE

UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE

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INTRODUCTION

The New Hampshire Agricultural Experiment Station resides within the College of Life Sciences and Agriculture at the University of New Hampshire. It has the responsibility for the Hatch, McIntire-Stennis, Animal Health, and Multi-State Research Programs. This report of accomplishments does not include New Hampshire Cooperative Extension, which is a separate administrative unit in New Hampshire. However, there is effective coordination of appropriate programs among both units. During the past year the NH-AES administration established an AES Advisory Committee, comprised of representatives from its key stakeholder groups. Through this committee, we hope to improve stakeholder input and our delivery of research findings to end users.

A. Planned Programs

Goal 1: An Agricultural System that is Highly Competitive in the Global Economy

Issue

Provide both basic and applied research to support increased knowledge to improve production, marketing and processing of American agricultural products.

Overview:

The New Hampshire AES has established increasing the effectiveness of basic and applied projects related to New Hampshire agricultural needs as an outcome indicator. Additionally, we use the increase in agricultural production in New Hampshire and growth in income to New Hampshire farm operations as indicators. Based on the most recent data available from the USDA's New England Agricultural Statistics Service*, the number of NH farms remained stable between 2000 and 2001 (but greater than ten years ago). During this same period, the contribution to the State's Economy by agricultural sector output increased from $172.3 to $177.4 million, while net farm income decreased from $13.6 to $12.6 million, respectively. Total farm assets increased from $958.2 to 989.2 million between 1999 and 2000, while total farm debt increased during this same period from 103.7 million dollars to 107.1 million dollars.

(*) Sources: New England Agricultural Statistics, 2001 and 2002

We continue a philosophy that the mission of the Agricultural Experiment Station is greater than solely enhancing production agriculture and thus provide support to basic and applied sciences that help posture NH to 1) develop new agricultural products and jobs, 2) maintain and enhance farm-based and farm-related industry and income, 3) provide opportunities for non-traditional farming endeavors, and 4) create opportunities for farm and rural community development. Each of these areas contributes to developing and assuring an agricultural system that is highly competitive in the global market.

The NH Agricultural Experiment Station supports the following basic and applied projects within Goal I to create technology and research for the benefit of the state, region and nation. We believe these projects provided excellent results and value from the investment of AES funds and have positioned the NH AES well to successfully achieve the goals of its five year POW plan.

Key Theme - Animal Production Efficiency

1. Improve supply of nutrients to dairy cows

   a. Brief description of the activity
   Two projects are devoted to this issue. Considerable improvements in milk production and the efficiencies of conversion of feed nitrogen to milk protein can be realized by optimizing intestinal supplies of lysine and methionine. Better utilization of dietary nitrogen will also reduce its levels in the animal waste stream, which has been of growing environmental concern. However, increasing intestinal supplies of lysine and methionine in ruminants requires dietary supplements of these amino acids designed to escape ruminal fermentation and yet be intestinally digestible. These projects are focusing on the establishment of optimal lysine and methionine requirements and the screening of available products to obtain accurate estimates of their bioavailability for lactating dairy cows and growing heifers.

   b. Short Impact/Accomplishment Statement
   This research is contributing to a better understanding of amino acid metabolism in cattle. When findings are applied in diet formulation for lactating cows, increases in conversion of feed nitrogen to milk protein of 20% or more have been reported. Similarly, when applied to growing heifers, the results increase the conversion of feed nitrogen to animal protein. These results contribute to reduced losses of excreted nitrogen and increased herd profitability.

   c. Source of funding/total expenditures/full time equivalents
   Source of funding: Hatch
   Total expenditures: Federal - $117,408
   State- 259,190
   Total - 376,598
   Full-time equivalents: Sci. 0.6; Tech 0.7; Lab&Cler. 0.5; Total 1.8

Scope of impact: Multistate; Integrated Research and Extension Project 1, Multistate research: (AL, AZ, CA, DE, FL, IL, IN, IA, KS, KY, LA, MD, MI, MN, MO, NH, ND, OH, PA, SD, UT, WA, WI, USDA/DFRC, USDA/RN)

Project 2: Multistate research (CA, FL, GA, IN, IA, KS, KY, LA, MI, MN, NE, NH, NYG, OH, PA, SD, TX, VA, WI).

2. Predicting bovine fertility

a. Brief description of the activity

Fertilization failure and early embryonic loss have a major economic impact on the dairy industry. Three independent projects at NH contribute to a multistate effort to understand the relationship between sub-luteal function, follicle development and fertility to enable design strategies to improve reproductive efficiency.

b. Short Impact/Accomplishment Statement

In lactating dairy cattle, postpartum estrous cycles with two waves of follicular development preceding insemination occurred more frequently but resulted in lower fertility than estrous cycles with three waves of follicular activity. Also, luteal function was extended and peak progesterone levels occurred later in three-wave cows. If follicular wave pattern is genetically determined, selection strategies might be developed to identify individuals with genetic traits that favor offspring with three follicular waves, and thus contribute to enhanced fertility. Additionally, a greater understanding of the relationship between ovarian function and fertility may enable design of strategies to improve reproductive efficiency. To that end, matrix metalloproteinases and their endogenous inhibitors were identified and their activities characterized throughout the lifespan of the corpus luteum.

c. Source of funding/total expenditures/full time equivalents (for 3 projects)

Source of funding: Hatch
Total expenditures: Federal - $103,446
State- 66,695
Total - 170,141
Full-time equivalents: Sci. 0.9; Prof 1.2; Lab&Cler. 2.1; Total 4.2

d. Scope of impact: Multistate Research (CTS, MA, NH, NYC, OH, PA, WVA)

3. Improving nutrition for dairy calves

a. Brief description of the activity

Calf growth and health were monitored during and after feeding lactoferrin, a milk protein with antimicrobial and possibly intestinal growth promoting attributes. In one of two studies, weaning age was hastened in calves supplemented with lactoferrin. In both studies, calves grew better and were more efficient feed utilizers when fed 1g/d of lactoferrin during the preweaning period. Calves supplemented with lactoferrin also had fewer ill days and a lower incidence of diarrhea. Thus, lactoferrin may prove to be an adequate means of reducing disease incidence without using antibiotics in neonatal calves.

b. Short Impact/Accomplishment Statement

Feed companies have expressed an interest in adding lactoferrin to their milk replacers. Results have also lead to further research with lactoferrin, especially on the development of the intestinal epithelium. Industry is beginning to support research in this area.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $15,501
State- 37,280
Total - 52,781
Full-time equivalents: Sci. 0.3; Prof. 0.3; Total 0.6

d. Scope of impact: Multistate Research (CA, FL, GA, IN, IA, KS, KY, LA, MI, MN, NE, NH, NY, OH, PA, SD, TX, VA, WI)

4. Lobster habitats and survival

a. Brief description of the activity

The overall goal of this project is to develop an improved method for measuring the area fished by a trap, so that catch data can be translated into a calculation of the actual abundance of lobsters on the bottom. To date, 35 lobsters equipped with transmitters have been monitored within a 50 x 50 meter underwater enclosure via the VEMCO tracking system, for a total of 170 lobster days. A baited trap equipped with a pinger and video camera were employed to characterize the distances from which lobsters were attracted to the trap and their rate of capture. In general, lobsters were attracted from a distance of 10 meters, depending on current direction. Some lobsters approached the trap but did not enter. Additional data will be required before final conclusions regarding the area of bait attraction can be reported.

b. Short Impact/Accomplishment Statement

Completion of this project will provide the groundwork necessary to formulate a model capable of estimating the abundance of lobsters on the bottom. To date, no such model exists because many aspects of lobster behavior in the field have yet to be determined. This project will provide information needed to create a more accurate model that is capable of tracking trends in the fishery. This information is vital for ensuring the sustainability of such a valuable commercial fishery.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $34,455
State- 47,185
Total - 81,640
Full-time equivalents: Sci. 0.8, Prof. 0.3; Total 1.1

d. Scope of impact: State Specific

5. Regulation of bovine follicular activity

a. Brief description of the activity

This study is aimed at elucidating molecular mechanisms for the activation of estrogen receptors in bovine follicles.

b. Short Impact/Accomplishment Statement

Methods have been optimized for using antibodies to determine when receptors for the hormone estrogen are in their active state. These antibodies may allow identification of drugs that may prove useful in modulating reproductive events in livestock species. In addition, identification of active forms of estrogen receptor and peptides that can potentially block the action of estrogen receptors may help to predict which tumors of animals or humans will be responsive to anti-estrogen drugs such as tamoxifen.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $13,014
	State- 3,839
	Total - 16,853
Full-time equivalents:	Sci. 0.4; Total 0.4

d. Scope of impact: State Specific

Key Theme - Animal Health

1. Genomic basis for resistance to avian diseases

a. Brief description of the activity

Crosses between different chicken genotypes indicate that tumor growth differs over time between different crosses. Data from the present study demonstrate that the L - alloantigen system or closely linked genes affect the anti-Brucella abortus response in chickens of the B2B2 genotype.

b. Short Impact/Accomplishment Statement

An understanding of genes that impact poultry disease resistance will enable more efficient poultry production. Improved health represents a substantial economic benefit to poultry breeders and producers.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $39,355
	State- 195,438
	Total - 234,793
Full-time equivalents:	Sci. 0.4; Prof 0.4; Lab&Cler. 2.0; Total 2.8

d. Scope of impact: Multistate Research (AL, AR, CA, CTS, DE, IA, NH, NYC, NC, SC, TX).

2. Characterizing avian tumor viruses

a. Brief description of the activity

The objective of this study is to characterize the genetic basis for Rfp-Y, B complex and nonMHC control of oncogene tumors. In one study, B complex recombinants (R1-R6) were

used to investigate the primary and secondary antibody responses to sheep red blood cells (SRBC). The results indicated that congenic lines carrying six B complex recombinants differed in their primary and secondary antibody response to SRBC's. In addition, the response to SRBC's was examined in B2B2 progeny with either Y1.2Y4 or Y4Y6 genotypes. There was no significant Rfp-y genotype effect for the primary or total mercaptoethanol-resistant antibody titers in response to SRBC's. However, secondary antibody titers were higher for birds with the Y1.2Y4 vs Y4Y6 genotype.

b. Short Impact/Accomplishment Statement
Increased knowledge of the genes controlling the chicken immune system benefits poultry production, through breeding and selection programs that reduce the incidence and severity of disease.

c. Source of funding/total expenditures/full time equivalents
Source of funding: Hatch- animal health
Total expenditures: Federal - $4,067

Full-time equivalents: Sci 0.1; Total 0.1

d. Scope of impact: State Specific

3. Causes of soft shell clam decline
a. Brief description of the activity
Fish and shellfish disease diagnosis, treatment and prevention are among the most significant variables in aquaculture. Since a large portion of clams are susceptible to clam leukemia, leading to a decline in populations, molecular biology studies were undertaken to address this problem. Integral roles for p53 and p63/73 genes and their gene products have been demonstrated in clam leukemia, whereby lack of function of these proteins is related to their exclusion from the nucleus. It was hypothesized that if p53 and p63/73 proteins could be made to accumulate in the nucleus, then apoptosis should preferentially destroy leukemic cells allowing diseased clams to recover. The administration of doxorubicin or etoposide to leukemic clam hemocytes in vitro resulted in translocation of p53 and p63/73 proteins from the cytoplasm to the nucleus, followed by increased DNA damage, apoptosis and cytotoxicity. In vivo treatment of leukemic clams with mitoxantrone, doxorubicin or etoposide produced similar translocation of these proteins which was also followed by DNA damage and apoptosis. These agents will now be tested with aquacultured clams in an effort to develop and maintain leukemic-free stocks.

b. Short Impact/Accomplishment Statement
Convincing evidence has been gathered that demonstrates integral roles for p53 and p73 genes and their products in clam leukemia. These studies also have provided a mechanism to successfully treat this clam disease, which can be applied for developing and maintaining leukemia-free seed stocks for the aquaculture industry.

c. Source of funding/total expenditures/full time equivalents
Source of funding: Hatch

Total expenditures: Federal - $35,220
State- 19,248
Total - 54,468
Full-time equivalents: Sci. 0.4; Prof 0.2; Total 0.6

d. Scope of impact: State Specific

Key Theme - Niche Market

1. Food system performance
a. Brief description of the activity
Three surveys were conducted: the first focused on specialty food firms in New Hampshire; the second involved food processors in New Hampshire; and the third studied consumers' reported purchasing behavior at direct marketing outlets such as farm stands, farmers' markets, and pick-your-own operations in New Hampshire. The first two studies measured the size and scope of the specialty-food and general food processing industries, the firms' business practices and their contribution to the state economy. The third study will identify consumer preferences and attitudes when shopping for products at direct marketing outlets.

b. Short Impact/Accomplishment Statement
These studies are expected to help food processors and farmers in New Hampshire improve their marketing strategies and practices. They are also expected to raise citizen awareness of the importance and contribution of agriculture and the food processing industry in the state.

c. Source of funding/total expenditures/full time equivalents
Source of funding: Hatch
Total expenditures: Federal - $34,554
State- 14,832
Total - 49,386
Full-time equivalents: Sci. 0.4; Prof 0.2; Total 0.6

d. Scope of impact: Multistate Research (IN, IA, NE, NH)

Key Theme - Plant Production Efficiency

1. pH and plant nutrition relationships
a. Brief description of the activity
Out-of-range medium-pH and associated imbalances with micronutrient deficiency or toxicity are the most common greenhouse nutritional problems. One objective of this study was to classify cultivars into iron-efficient, iron-inefficient or intermediate groups. In addition, this study examined approaches for managing pH and the availability of micronutrients in greenhouses containing multiple crops.

b. Short Impact/Accomplishment Statement
This project has provided directly-applicable information for industry on how to group plants

according to iron efficiency, how to raise medium pH using flowable lime or potassium bicarbonate, and use of iron chelate drenches to correct pH problems. By correctly managing micronutrient levels and pH, NPK loading can be reduced in greenhouses, because growers often over-apply complete, blended fertilizer in order to supply sufficient micronutrients.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $36,422
State- 16,626
Total - 53,048
Full-time equivalents: Sci. 0.1; Prof 0.6; Total 0.7

d. Scope of impact: State specific

2. Control of plant growth systems

a. Brief description of the activity

High-pressure sodium lighting (HPS) continued to be evaluated for effects on development of seedling nursery plugs. The results indicate that to increase plug growth, 40 micromol/m2/s is required for impatiens under north eastern conditions, but that 12 micromol/m2/s is sufficient to induce early flowering in highly photoperiodic species such as petunia. Financial analyses are being performed to assess profitability and return on investment.

b. Short Impact/Accomplishment Statement

Lighting of greenhouse plugs is relatively expensive technology, and lack of information limits its adoption. Current research coupled with economic analyses will help growers make informed management decisions and maximize return on investment in HPS.

c. Source of funding/total expenditures/full time equivalent

Source of funding: Hatch
Total expenditures: Federal - $11,472
State - 994
Total - 12,466
Full-time equivalents: Sci 0.1; Total 0.1

d. Scope of impact: Multistate research (AZ, CTH, NYC, NH, NJ, CTS, KY, MI, OH, PA)

3. Genetics and breeding of Cucurbita

a. Brief description of the activity

Several hull-less seeded pumpkin varieties were compared for growth, pattern of flowering, fruit yield, seed size and seed dry weight yield. Nitrogen fertilization was also examined for a hybrid snackseed pumpkin variety grown on raised beds with black polyethylene and drip irrigation. A study of peduncle (fruit stem) maturation was also conducted with four hybrids of jack o'lantern pumpkins.

b. Short Impact/Accomplishment Statement

These programs have resulted in the development and release of several hull-less seed hybrids, and the commercial production of "Snackjack" hull-less pumpkin seeds as a new, nutritious snack food. Fifteen curcurbit varieties have been released over the past ten years as a result of this project and are being marketed commercially, with wholesale seed sales of about one million dollars. Documenting the extent of hybrid vigor and potential seed yields will provide growers with a means for increasing potential economic yields and profit margins with these products. In addition, nitrogen fertilization is likely to be especially important for pumpkin seed production because of their high protein content. At the same time, the most important trait of a pumpkin for marketing is having an intact and sturdy stem that does not shrivel after harvest. Scientific data on stem maturation were previously lacking, so these results will assist growers in knowing when to harvest pumpkins, and will be useful to breeders in evaluating breeding lines with good fruiting stem quality.

c. Source of funding/total expenditures/full time equivalents (for 2 projects)

Source of funding:	Hatch
Total expenditures:	Federal - $60,078
	State- 134,434
	Total - 194,512
Full-time equivalents:	Sci. 0.2, Prof 0.1; Tech 0. 9; Total 1.2

d. Scope of impact: State Specific

4. Strawberry production in modified environments

a. Brief description of the activity

A planting and plant management system including the use of black plastic covered raised beds, late summer planting of plug plants, and winter protection using floating row covers was evaluated for the potential to increase strawberry yields while reducing the need for soil fumigation.

b. Short Impact/Accomplishment Statement

Currently more than 30 New England growers, including 12 New Hampshire growers, have adopted this production technique. This system allows growers to quickly adjust planting to meet market demand, makes more efficient use of labor by moving planting from a period of peak labor demand to late summer when labor demand has decreased, and allows strawberry production without the use of soil fumigation. In addition, pre-emergence herbicides are not needed with this system. This system should become an important tool for organic strawberry growers in particular, as with this system there is reduced insect and fruit rot pressure. It is expected that this system will we be used on 250 acres in New England and will eliminate the use of 4000 lb of pre-emergence herbicides per year.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $30,236
	State- 88,339
	Total - 118,575

Full-time equivalents: Sci. 0.5, Tech 0.4, Total 0.9

d. Scope of impact: Integrated Research and Extension; state specific

5. Genetic control of strawberry

a. Brief description of the activity

Molecular tools are being used to assess genes of economic importance in strawberries. The association between candidate anthocyanin genes and fruit color variation was studied using crosses among wild and cultivated diploid Fragaria accessions, and the complete sequence of the F3H transcriptional unit and partial promoter sequence were obtained for several accessions. In addition, molecular markers tightly linked to the s locus governing day neutral flowering habit have been identified, and two genetic/reproductive phenomena affecting the development of diploid strawberry mapping populations were investigated.

b. Short Impact/Accomplishment Statement

The results achieved by this investigation contribute to an ongoing effort to characterize and exploit naturally occurring genetic variability in the genus Fragaria, with the goal of providing knowledge and resources in support of strawberry germplasm development and preservation, and strawberry improvement. It is expected that the molecular identification of a key determinant of strawberry fruit color variation, the F3H gene, will be exploited by breeders interested in employing molecular markers as an aid to choosing parental material for crosses, and for selecting genetically superior progeny. The results have laid the foundation for future progress on strawberry genetic research in the areas of gene identification and cloning, identifying and overcoming barriers to hybridization and gene introgression, and the identification (and hopefully preservation) of the wild diploid progenitors of the cultivated strawberry.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $55,510
State- 57,503
Total - 113,013
Full-time equivalents: Sci. 0.4; Prof 0.6; Tech 0.4; Total 1.4

d. Scope of impact: State specific

6. Evaluation of new apple cultivars

a. Brief description of the activity

Since apple growers in NH are struggling to survive a weak wholesale market, this project seeks to develop retail/wholesale markets for specialty apple cultivars not available through traditional market channels. Data collected include harvest date(s), number of fruit harvested and total weight, starch iodine rating, length/diameter ratios, drops and drop weight, and storage quality out of cold storage. Several cultivars have been tentatively identified for grower trial at the roadside stand and U-pick markets.

b. Short Impact/Accomplishment Statement

The conversion of an industry largely dependent on McIntosh produced for the wholesale, fresh market to direct retail sales requires that growers offer consumers unique and exceptional varieties. This research has identified several cultivars with such potential, and growers are beginning to order those that are available for commercial trial.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $1,724
State- 14,648
Total - 16,372
Full-time equivalents: Sci. 0.2; Total 0.2

d. Scope of impact: Multistate; Integrated Research and Extension (AL, UT, OR, NC, NYG, NJ, PA, OH, VT, MA, IN, MI, CTH, NYC, NH, ME, AR, NYC, VA)

7. Conservation of plant genetic resources

a. Brief description of the activity

A glabrous trait (glossy, spineless petioles) has been bred into yellow straightneck squash to reduce fruit injury during harvest and to make hand harvest easier, and several experimental F1 hybrids have been compared to a popular commercial cultivar. Similarly, experimental F1 hybrids of acorn squash with powdery mildew tolerance were compared to the two most popular disease-susceptible commercial acorn hybrids, and 56 melon hybrids with resistance to powdery mildew and one or two races of fusarium wilt were compared. Among the latter, most of these varieties are adapted to a short growing season in northern latitudes and, in addition, to better disease resistance than currently available with short-season varieties. Furthermore, they have better shelf life, an important quality criterion for local as well as wholesale markets.

b. Short Impact/Accomplishment Statement

Flesh quality in acorn squash is variable and currently popular hybrids have poor eating quality. New hybrids could increase sales of acorn squash and provide a better product for roadside markets. In addition, resistance to powdery mildew and other diseases in squash and/or melons should reduce pesticide inputs while increasing product quality and profitability.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $10,450
State-7,110
Total - 17,560
Full-time equivalents: Sci 0.3; Total 0.3

d. Scope of impact: Multistate (CA-D, CTS, DE, MA, ME, NH, NJ, NYG, PA, RI)

8. Role of ethylene in signal transduction in plants

a. Brief description of the activity

Microarray analysis of Arabidopsis was used to compare gene expression between the ethylene-insensitive mutant etr 1-1 and the constitutive ethylene response mutant ctr 1-2, using both light- and dark-grown seedlings. Genes were identified that were differentially expressed under only one or both conditions. Gene expression was also compared in response to salt stress, and revealed that salt stress represses the expression of the ethylene receptors ETR2, ETR1 and ERS1. The results indicate that ethylene-insensitive plants are more sensitive to salt and osmotic stress than wildtype. Also, plants with mutations that result in a constitutive ethylene response are more resistant to salt and osmotic stress than wildtype.

b. Short Impact/Accomplishment Statement
Ethylene is a plant hormone involved in aspects of plant growth and development, including fruit ripening, organ abscission and stress responses. This work is leading to a better understanding of how ethylene signaling is regulated in the plant and will allow for modification of these economically important traits.

c. Source of funding/total expenditures/full time equivalent
Source of funding: Hatch
Total expenditures: Federal - $11,981
State- 42,046
Total - 55,027
Full-time equivalents: Sci. 0.2; Prof. 0.7; Total 0.9

d. Scope of impact: State Specific

9. Nutrient management for ornamental plants
a. Brief description of the activity
Nitrogen fertilization frequency and time of application are being investigated for effects on three deciduous woody species: Fraxinus pennsylvanica, Syringa vulgaris and Viburnum trilobum.

b. Short Impact/Accomplishment Statement
To date, it appears that application of nitrogen may serve no benefit in enhancing growth in the first two years after planting. Long-term results from this trial will be used to develop sound nitrogen fertilization recommendations for nursery production and landscape maintenance, which will result in economic savings and environmental protection.

c. Source of funding/total expenditures/full time equivalents
Source of funding: Hatch
Total expenditures: Federal - $14,330
State- 58,486
Total - 72,816
Full-time equivalents: Sci. 0.3; Tech 0.4; Total 0.7

d. Scope of impact: State specific

10. Breeding and genetics of ornamental plants

a. Brief description of the activity

This study is aimed at developing and evaluating new lines of ornamental plants that are suitable for use in the northeast.

b. Short Impact/Accomplishment Statement

Two new vegetatively-propagated cultivars of annual Anagallis (Pimpernel) have been released commercially. We expect release of additional cultivars of Anagallis and other annuals in subsequent years. Collaboration with other researchers is in progress to obtain new information on flower color genetics in Anagallis, and taxonomic relationships in Nolana.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $12,272
	State- 10,935
	Total - 23,208
Full-time equivalents:	Sci. 0.4; Total 0.4

d. Scope of impact: State specific

11. Nutrient management on organic farms

a. Brief description of the activity

The goals of this project are to improve nutrient management on farms that use organic soil amendments as a fertility source and to determine environmentally sound cropping practices for forage soybean.

b. Short Impact/Accomplishment Statement

The studies on nutrient management on organic farms will answer the question of how much organic farms are at risk of negatively impacting the environment with current management practices, while defining best management practices for the use of organic amendments. The forage soybean study is expected to show if cover cropping is a feasible option to reduce the risk of erosion when farmers switch from the perennial alfalfa to the annual forage soybean in their crop rotation. Additionally, it will address the question of whether the higher soil fertility provided by manure amendments can contribute to better weed management.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $8,166
	State-2,023
	Total - 10,189
Full-time equivalents:	Sci. 0.4; Total 0.4

d. Scope of impact: State specific

Key Theme - Plant Health

1. Inhibition of photosynthesis by UV-radiation

a. Brief description of the activity

Two projects are assessing this issue. These efforts are investigating 1) long-term effects of high salinity on growth, photosynthesis and antioxidant parameters, and 2) whether UV-B radiation is detected via the redox system in chloroplasts.

b. Short Impact/Accomplishment Statement

Salinity is a major stress factor reducing crop productivity world-wide. The precise roles of antioxidants in mediating this stress are not understood. Dunaliella is the most salt-tolerant eukaryotic photosynthetic organism known. An improved knowledge of its antioxidant responses to salt stress can be significant in efforts to improve crop plants. Additionally, the response of chloroplasts to UVB radiation may further our understanding of the role of chloroplasts as environmental monitors for plant cells.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $19,631
	State- 48,701
	Total - 68,332
Full-time equivalents:	Sci. 0.8, Total 0.8

d. Scope of impact: State Specific

2. Genetic and molecular control of carrot embryogenesis

a. Brief description of the activity

The goal of this project is to gain an understanding of the role of polyamine metabolism in somatic embryogenesis in carrot. Results have shown that polyamine metabolism changes considerably during the development of somatic embryos; enhanced polyamine biosynthesis causes an enhancement of somatic embryogenesis, and enhancement of polyamine biosynthesis results in an increase in polyamine catabolism.

b. Short Impact/Accomplishment Statement

The results will help us in mass propogation by somatic embryogenesis in plants that are difficult to clone, and may help us in producing plants with improved nutritional value via genetic manipulation.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $10,041
	State- 38,887
	Total - 49,928
Full-time equivalents:	Sci. 0.1, Prof. 0.1; Total 0.2

d. Scope of impact: State Specific

Key Theme - Plant Genomics

1. Molecular biology of seed coat development in pumpkin
   a. Brief description of the activity
   This research is aimed at identifying genes that are differentially expressed in the wild type and hull-less seeds of pumpkin during their development.

   b. Short Impact/Accomplishment Statement
   The results will help us genetically manipulate the quality of seed coat in cucurbits and other plants, and produce seeds with thin, edible seed coat, thus increasing their nutritional and commercial value.

   c. Source of funding/total expenditures/full time equivalents
   Source of funding: Hatch
   Total expenditures: Federal - $10,037
   Total - 10,037
   Full-time equivalents: Sci 0.1, Prof 0.4, Total 0.5.

   d. Scope of impact: State specific

2. Calcium control of plant enzyme activity
   a. Brief description of the activity
   Plants are able to detect and respond to changes in their environment by altering their metabolism. This project analyses the expression patterns of calcium-dependent protein kinase in transgenic Arabidopsis.

   b. Short Impact/Accomplishment Statement
   An understanding of how plants sense and respond to internal and external stimuli at the molecular level is important for understanding growth and development and also for discerning how a plant responds to its physical environment. Member of the calcium-dependent protein kinase (CDPK) family are involved in plant defense responses as well as responses to hormones, cold stress, drought stress, and wounding. Most plants contain many CDPK genes and it is hypothesized that different CDPK proteins perform defined functions. This research provides evidence to support that hypothesis, since different CDPKs were found to be expressed in different spatial and temporal patterns and to be localized to different subcellular locations.

   c. Source of funding/total expenditures/full time equivalents
   Source of funding: Hatch
   Total expenditures: Federal - $10,494
   State- 38,656
   Total - 49,150
   Full-time equivalents: Sci. 0.4, Prof. 0.6; Total 1.0

d. Scope of impact: State Specific

Key Theme - Aquaculture

1. Genetic improvement of tilapia for aquaculture

a. Brief description of the activity

Two projects are devoted to this objective. A significant problem in culture of this species is the early reproduction by females during grow-out. This results in production of a large number of undersize fish which are not suitable for filleting. Thus, one project has focused on genes controlling sex, in order to select broodstock for the natural hybrid production of all-male progeny. The focus of a second project is to develop genetic, physical and comparative linkage maps of tilapia

b. Short Impact/Accomplishment Statement

A preliminary patent application has been submitted on the utility of markers for tracking sex chromosomes in tilapia. We anticipate their application in commercial breeding programs which intend to develop defined inbred lines which can be crossed to reliably yield all male progeny for production. In addition, genetic and physical linkage maps are being used to positionally clone genes for controlling sex determination, body color and growth rate in tilapia. Knowledge of the genetic basis of these traits will facilitate the genetic improvement of tilapia for commercial aquaculture.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $36,738
State- 5,874
Total - 42,612
Full-time equivalents: Sci. 0.2, Prof. 0.4; Total 0.6

d. Scope of impact:

1. State specific
2. Multistate Reseach (AL, CA, CTS, NH, LA, NJ)

2. Increased efficiency of producing sea urchin roe

a. Brief description of the activity

A demonstration hatchery system for green sea urchins has been established to promote aquaculture of sea urchins for both stock enhancement and sea ranching on leased sites. Cultivation with Isochrysis and Duneliella were positive and juvenile urchins were produced for the third year in a row. Field based growth studies with both suspended and bottom cages suggest that suspended cages are more effective for juvenile growth.

b. Short Impact/Accomplishment Statement

Green urchin in the Gulf of Maine have recently shown a consistent decline in population, demonstrating the need for hatcheries or sea-ranching. The components for a demonstration sea urchin hatchery are in place and have been successfully tested on a limited scale. The hatchery system has been expanded to operate at near commercial scale in the winter of 2003

and outreach to interested urchin harvesters in underway to test out planting of hatchery produced urchins as several locations along the Maine coast.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $14,447
State- 46,870
Total - 61,317
Full-time equivalents: Sci. 0.4, Prof. 0.6; Total 1.0

d. Scope of impact: State Specific

3. Control of pigment production of summer flounder

a. Brief description of the activity

Summer flounder change pigmentation as they develop. This project has demonstrated that the malpigmentation common in hatchery-reared flatfishes is caused by a spatially inappropriate expression of normal developmental pathways at premetamorphic stages. Nutritional and other factors that may interact with developmental patterning mechanisms should be a target of future investigation.

b. Short Impact/Accomplishment Statement

The detailed knowledge generated by this study allows more precise assessment of different rearing strategies designed to improve pigmentation in hatchery-reared fish, which will enhance the development of intensive aquaculture for this and other flatfish species.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $0.00
State- 30,193
Total - 30,193
Full-time equivalents: Total 0.0

d. Scope of impact: State Specific

4. Photosynthesis-light relationships in the seaweed Porphyra

a. Brief description of the activity

This project seeks to identify the best candidate species for integrated aquaculture in which Porphyra will be used to remove excess nutrients from the wastewater of finfish tanks. A second aspect of the study has been to improve the taxonomic classification of native species of Porphyra.

b. Short Impact/Accomplishment Statement

The evaluation of photosynthesis-light relationships in native species of Porphyra has contributed to the selection of the best candidate for polyculture. Six previously-undescribed species from the Northeast coast have been characterized, and this species characterization work has instigated a significant taxonomic revision of the genus Porphyra in the

Northwestern Atlantic.

c. Source of funding/total expenditures/full time
Source of funding: Hatch
Total expenditures: Federal - $8,401
State- 40,365
Total - 48,766
Full-time equivalents: Sci. 0.4; Prof 0.5; Total 0.9

d. Scope of impact: State specific

Key Theme - Other

1. Genetic transposition in soil nematodes
a. Brief description of the activity
Soil nematodes have the potential to be beneficial or harmful to agriculture. This project is focused on elucidating genetic mechanisms that ensure genome stability.

b. Short Impact/Accomplishment Statement
Cloning and further characterization of mut genes will elucidate the function of each gene and the role of each in transposon control, RNAi and other processes in the C. elegans germ line. The work has direct implications for agriculturally important nematodes.

c. Source of funding/total expenditures/full time equivalents
Source of funding: Hatch
Total expenditures: Federal - $10,787
State- 49,198
Total - 59,985
Full-time equivalents: Sci. 0.4; Prof. 0.4, Total 0.8

d. Scope of impact: State Specific

2. Character and control of yeast regulatory genes
a. Brief description of the activity.
This study is investigating the functional and physical interactions of yeast regulatory genes.

b. Short Impact/Accomplishment Statement
Findings from this investigation are important to understanding how gene expression is controlled both in terms of its synthesis and degradation. Close connections have been demonstrated between two regulatory complexes that appear to control several aspects of gene expression. Since these protein complexes are found in all eucaryotes, these studies may have broad implications in understanding gene regulation in medically and agriculturally important organisms.

c. Source of funding/total expenditures/full time equivalents
Source of funding: Hatch

Total expenditures:	Federal - $13,288
	State- 70,207
	Total - 83,495
Full-time equivalents:	Sci. 0.4; Prof. 0.4, Total 0.8

d. Scope of impact: State specific

Program Duration

The research projects that contribute to this goal are generally of three to five years duration. All projects are targeted for mid and long term problems.

In fiscal year 2002 the New Hampshire Agricultural Experiment Station had 10.6 full time equivalents of scientists time assigned to Goal 1. Their research was funded with federal funds from the Hatch, McIntire-Stennis, and Multi-State Research Programs. There were 7.4 full-time equivalents of technical and clerical staff attached to these projects. Professional help, in the form of graduate students doing research on these projects, amounted to 8.0 students. For this goal, as well as all subsequent goals, there are matching funds from the State of New Hampshire through a budget line within the University of New Hampshire's budget. It is not anticipated that any change in federal funding in the next five years would significantly alter the spectrum of key program components for Goal 1.

Goal 2: A Safe and Secure Food and Fiber System

Issue: Foods are in constant threat of contamination by microorganisms. The agricultural system has a responsibility to ensure that the foods produced are safe to eat.

Overview:

The New Hampshire AES has established output indicators for Goal 2 as follows: 1) increase research results from projects dealing with microorganisms that are potential harmful contaminants of foods and 2) increase understanding of the processes whereby harmful microbes carry out their infective and disease-causing processes. As outcome indicators, we evaluate 1) an absence or decease of bacterial contamination of foods and 2) the level of public awareness of the contribution of pathogenic microbes to animal and human illness. We continue a philosophy that the mission of the Agricultural Experiment Station is consistent with Goal 2 and thus provide support to basic and applied sciences that help posture NH to 1) reduce bacterial illness, 2) determine the role of bacterial genes in diseases, 3) provide defense mechanisms against pathogenic bacteria, and 4) assess the impact of pathogenic bacteria on humans, animals and the environment. We also support programs to enhance public awareness of food safety issues. The NH Agricultural Experiment Station also supported the following basic and applied projects within Goal 2 to create technology and research for the benefit of the state, region and nation. We believe these projects provided excellent results and value from the investment of AES funds and have positioned the NH AES well to successfully achieve the goals of its five year POW plan.

Key Theme - Food Safe

1. Role of bacterial genes in diseases

a. Brief description of the activity

All microorganisms, including pathogens, face stressful conditions in their various environments. This project uses molecular and genetic techniques to create microbial mutations to provide information on how these microorganisms can be controlled, and possibly eliminated, with particular emphasis on pathogens.

b. Short Impact/Accomplishment Statement

Discovery of a new gene that influences toxin production in E. coli 0157:H7 should provide a better understanding of the pathogen in general. The use of such genetic variants, as well as antimicrobials, should provide a means for controlling the spread of the pathogen in various environments.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $11,719
State- 40,492
Total - 52,211
Full-time equivalents: Sci. 0.4, Prof. 0.1; Total 0.5

d. Scope of impact: State Specific

2. Host defenses against Salmonella

a. Brief description of the activity

This study is investigating the role of major outer membrane proteins in host cell recognition and response to Salmonella, and factors associated with the ability of neutrophils to kill various strains of this organism.

b. Short Impact/Accomplishment Statement

Salmonellosis continues to be a major foodborne disease in the United States and worldwide. This project has demonstrated that S. Enteritidis adheres to human neutrophils and induces the release of IL-8 from these cells, but that these activities are not mediated by OmpC. These studies are expected to enhance our understanding of the early events in infections due to salmonella and to facilitate our ability to prevent such infections from progressing into clinical disease.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $25,581
State- 30,173
Total - 55,754
Full-time equivalents: Sci. 0.3; Prof. 0.3; Total 0.6

d. Scope of Impact: State specific

3. Impact of microcystins on lakes

a. Brief description of the activity

This study focuses on the presence of cyanobacterial hepatotoxins, called microcystins, in the food webs of NH lakes.

b. Short Impact/Accomplishment Statement
Mycocystin toxicity is a worldwide problem that is increasing in frequency as lakes become more eutrophic. While we have identified the presence of mycocystins in the phytoplankton (cyanobacteria, aka blue-green-algae) on over 60 NH lakes, the specific sources of this potent liver toxin were not always evident. Thus, it is important to determine the specific sources of biotoxins so that appropriate toxin management protocols can be developed. This project will provide essential information regarding detection of potentially harmful algal blooms, assessment methods for toxicity, and a strategy for utilizing water quality monitors and other personnel in a rapid response protocol to ensure public safety.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $33,950
	State- 15,073
	Total - 49,023
Full-time equivalents:	Sci. 0.4, Prof. 0.3; Total 0.7

d. Scope of Impact: State Specific

Program Duration
All projects under this goal are for a three to five year period. All projects are targeted for mid and long term problems.

In fiscal year 2002 the New Hampshire Agricultural Experiment Station had 1.1 full time equivalents of scientists time assigned to Goal 2. Their research was funded with federal funds from the Hatch Program. There were 0 full-time equivalents of technical staff attached to these projects. Professional help in the form of graduate students doing research on these projects amounts to 0.7 student. For this goal, as well as all subsequent goals, there are matching funds from the State of New Hampshire through a budget line within the University of New Hampshire's budget. It is not anticipated that any change in federal funding in the next five years would significantly alter the spectrum of key program components for Goal 2.

Goal 3: A Healthy, Well-Nourished Population
Issue: The reasons people eat particular foods are complex and the foods that are included in a diet have short-term and long-term health consequences. Knowledge of food-consumption patterns and the results of those choices are needed.

Overview:

The New Hampshire AES has established as output indicators for Goal 3, 1) increased research results from projects dealing with why particular foods that make up a diet are chosen

and 2) increased research results detailing the short and long term consequences of food consumption patterns on health issues.

We will evaluate as outcome indicators if our efforts within this goal are contributing to 1) healthier food choices resulting in a better balanced diet for consumers and 2) fewer incidences of disease or disorders directly related to improper diet choices.

We continue a philosophy that the mission of the Agricultural Experiment Station is consistent with Goal 3 and thus provide support to basic and applied sciences that help posture NH to 1) understand and control the metabolism and oxidation in adipose tissue, 2) assess the nutritional risk in the elderly, 3) understand relationships of diseases and gender or age, and 4) assess the functional properties of food protein. Each of these areas contributes to developing and assuring a healthy and well-nourished population. The NH Agricultural Experiment Station supports the following basic and applied projects within Goal 3 to create technology and research for the benefit of the state, region and nation. We believe these projects provided excellent results and value from the investment of AES funds and have positioned the NH AES well to successfully achieve the goals of its five year POW plan.

Key Theme - Human Health

1. Obesity, insulin resistance and asthma in women

a. Brief description of the activity

This project involves a cross-sectional study examining the effect of asthma and obesity on the Th2 phenotype (atopy).

b. Short Impact/Accomplishment Statement

The results demonstrate that atopy was greater and asthma quality of life scores lower among asthmatic vs non-asthmatic individuals, independent of body composition. Atopy and quality of life scores were also lower for obese vs non-obese individuals. Fasting insulin was shown to be a major predictor of quality of life scores. Obesity may be an important risk factor of the Th2 pathway toward atopy and asthma in women. Mechanisms of action may involve changes in insulin sensitivity. Thus, weight management and prevention of obesity may have important implications in preventing the development of allergies.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $25,380
	State- 152,682
	Total - 178,062
Full-time equivalents:	Sci. 0.4, Prof. 0.2; Tech 1.5 , Total 2.1

d. Scope of Impact: State Specific

2. Control of adipose tissue metabolism

a. Brief description of the activity

Adipose tissue blood flow (ATBF) can influence the rate at which nutrients are deposited into and removed from adipose tissue. This study seeks to elucidate factors that influence

ATBF in the Yucatan miniature swine model.

b. Short Impact/Accomplishment Statement
Findings from this study have demonstrated that both exercise and genetics influence ATBF, and suggest that individual variation in tissue remodeling enzymes may be responsible for animal-to-animal variation in adipose tissue morphology. In addition to human health implications, this information will impact the swine industry by permitting better control of factors that influence swine adipose tissue deposition.

c. Source of funding/total expenditures/full time equivalents
Source of funding: Hatch
Total expenditures: Federal - $16,761
State- 51,238
Total - 67,999
Full-time equivalents: Sci. 0.3; Prof 0.5; Total 0.8

d. Scope of Impact: State Specific

3. Molecular basis of retinal function
a. Brief description of the activity
Many blinding diseases and visual disabilities in animal and humans result from disorders of the photoreceptor cells (rods and cones) or the retina. This project characterizes isozyme-specific antibodies to cone and rod phosphodiesterase subunits for retinal photoreceptors.

b. Short Impact/Accomplishment Statement
Studying how cone photoreceptor cells function at the biochemical level is essential for understanding the initial events in daytime vision and color discrimination. This information is needed to develop effective treatments to slow or reverse diseases of the photoreceptor cells that lead to impairment of visual function or even total blindness. The advances in the understanding of the cone visual pathway, particularly of the cone phosphodiesterase enzyme, may help in designing better therapeutic agents that selectively target this enzyme in cone cells.

c. Source of funding/total expenditures/full time equivalents
Source of funding: Hatch
Total expenditures: Federal - $13,460
State- 52,502
Total - 65,962
Full-time equivalents: Sci. 0.4; Prof 0.1; Total 0.5

d. Scope of Impact: State Specific

4. Regulation of zinc transport
a. Brief description of the activity
This project is investigating the hypothesis that blood vessel endothelial cells comprise a

permeable barrier with the potential of regulating inter-organ distribution of Zn. This capacity would be important during periods of Zn malnutrition. One major focus during the past year was on the identification of putative zinc transporter proteins.

b. Short Impact/Accomplishment Statement
This study has demonstrated that the walls of the blood vessels in the brain adapt their transport and metabolism of zinc in order to protect the brain from receiving sub-optimal quantities of zinc during periods of zinc malnutrition. Two protein sequences have now been identified that may represent cellular zinc transporters in the pig. Ultimately, knowledge gained from these investigations may improve our ability to evaluate the significance of zinc malnutrition in the development of brain disorders such as Alzheimer's disease and dementia.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $31,025
	State- 43,095
	Total - 74,120
Full-time equivalents:	Sci. 0.4; Total 0.4

d. Scope of Impact: State specific

Key theme - Human Nutrition

1. Assessing the nutritional risk of the elderly
   a. Brief description of the activity
   The pigment located in the foveal region of the retina, known as the macular pigment, is composed of carotenoids. These are thought to act as antioxidants and to provide protection to the visual system. Since humans do not synthesize carotenoids, these must be of dietary origin, and dietary supplements are being marketed with a focus on eye health. However, much remains to be learned about carotenoid intake, absorption and deposition. This project has focused on dietary carotenoids and their deposition in the retina, as measured by macular pigment optical density.

   b. Short Impact/Accomplishment Statement.
   The development of optimal dietary carotenoid intake and/or supplement advice is dependent upon an understanding of the functions of carotenoids as well as the many variables that influence carotenoid status. In this study, it was found that one month of lutein supplementation resulted in higher serum carotenoid levels, but without effect on macular pigment optical density. The results of this research are contributing to our understanding of carotenoid nutrition, which should ultimately provide the basis for sound nutritional advice.

   c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $13,199
State- 79,236
Total - 92,435

Full-time equivalents: Sci. 0.4; Total 0.4

d. Scope of Impact: Multistate Research (CTS, DC, IL, ME, MD, MA, NH, NYC, RI)

2. Atherogenesis in normal and diabetic animals

a. Brief description of the activity

This project is examining the role of oxidized LDL receptors in atherogenesis in normal and diabetic animals.

b. Short Impact/Accomplishment Statement

The increased glucose levels seen in diabetic hamsters in this study were shown to put these animals at risk for cardiovascular disease equal to the well characterized effects of increased blood cholesterol. Hamsters with both elevated blood cholesterol and glucose were at greater risk for vascular disease than would be expected from the simple additive consequences of these two factors alone. Understanding this phenomenon may help clarify why diabetic individuals have accelerated cardiovascular disease. This information may lead to new treatments that may reduce the social and economic costs associated with diabetes and cardiovascular disease.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $30,145
State- 72,477
Total - 102,622
Full-time equivalents: Sci. 0.4; Tech 0.5; Total 0.9

d. Scope of Impact: State Specific

3. Atherogenesis at the cellular level

a. Brief description of the activity

In an effort to identify genetic causes for susceptibility to atherosclerosis, cDNA libraries are being constructed from arterial tissue of atherosclerosis-susceptible White Carneau and atherosclerosis-resistant Show Racer pigeons.

b. Short Impact/Accomplishment Statement

Genetic factors play a role in susceptibility to heart disease, since more than 50% of heart attacks occur in the absence of known risk factors. Heart disease in pigeons is the result of an autosomal recessive gene, independent of risk factors. Identification of this gene will help explain the development of heart disease in more complex cases such as humans.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $14,200
State- 58,979
Total - 73,179
Full-time equivalents: Sci. 0.4; Prof 0.3; Total 0.7

d. Scope of Impact: State Specific

Theme - Food Quality

1. Gelation of Beta-Lactoglobulin A and B
   a. Brief description of the activity
   This study is investigating the mechanisms involved in beta-lactoglobulin (B-Lg) gel formation and stabilization.

   b. Short Impact/Accomplishment Statement
   Blg is widely used as a nutritious food texturizer. Approximately 9 tons of Blg are produced every day, most of which is treated as waste material. In order to be useful as a texturizer or as a biomaterial (e.g., a saran), the characteristics of the dominant genetic variants of Blg must be determined. This study has shown that Bla and BlgB differ significantly in the stability of dimer formation, which leads directly to important differences in the textures of their resulting gels.

   c. Source of funding/total expenditures/full time equivalents
   Source of funding: Hatch
   Total expenditures: Federal - $15,489
   State- 65,025
   Total - 80,514
   Full-time equivalents: Sci. 0.5; Prof 0. 5; Total 1.0

   d. Scope of Impact: State specific

2. Nutritional content of vegetable brassicas
   a. Brief description of the activity
   This project focuses on the genetic and environmental influences on the nutritional content of the vegetable brassicas. One aspect of the investigation included the evaluation of 23 different kale cultivars for lutein and beta-carotene content. The influence of sulfur fertility on carotenoid content and the flavor attributes of kale was also investigated, along with field studies aimed at increasing calcium content.

   b. Short Impact/Accomplishment Statement
   Approximately 2.5 fold differences in carotenoid content were found among various kale cultivars. Sulfur fertilization did not increase the carotenoid content of kale, but lower sulfur fertilization rates reduced the undesirable bitter flavor associated with this vegetable. These results demonstrate that cultivar selection is vital to producing kale that has high levels of beneficial lutein and beta carotene, and that proper fertilization management will affect

flavor attributes. This information will allow commercial vegetable growers to produce superior leafy vegetable crops that can establish an advantageous marketing niche.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $20,429
State- 19,173
Total - 39,602
Full-time equivalents: Sci. 0.4; Prof 0.3 ; Tech 0.6; Total 1.3

d. Scope of Impact: State specific

Program Duration

The research projects that contribute to this goal are generally of three to five years duration. All projects are targeted for mid and long term problems.

In fiscal year 2002 the New Hampshire Agricultural Experiment Station had 3.6 full time equivalents of scientist's time assigned to Goal 3. Their research was funded with federal funds from the Hatch and Multi-State Research Programs. There were 2.6 full-time equivalents of technical and clerical staff attached to these projects. Professional help in the form of graduate students doing research on these projects amounts to 2.8 students. For this goal, as well as all subsequent goals, there are matching funds from the State of New Hampshire through a budget line within the University of New Hampshire's budget. It is not anticipated that any change in federal funding in the next five year's would significantly alter the spectrum of key program components for Goal 3.

Goal 4: An Agricultural system which Protects Natural Resources and the Environment

Issue: Agriculture is a human activity and as such goes on within a larger environment. Agriculture and forestry activity can have major impacts on soil and water and land ecology and its environment because of their direct links to soil, water, air, and biological resources.

Overview:

The New Hampshire AES has established as output indicators for Goal 4, research activity that deals with the problems associated with agricultural and forestry practices as related to the environment.

We will evaluate the outcome indicator of whether our efforts within this goal are contributing to an agricultural and forestry industry that causes minimal changes and produces very minor alterations to the environment yet is productive. We continue a philosophy that the mission of the Agricultural Experiment Station is consistent with Goal 4 and thus provide support to basic and applied sciences that help posture NH to maintain a sustainable environment and forest industry.

The NH Agricultural Experiment Station supports the following basic and applied projects within Goal 4 to create technology and research for the benefit of the state, region and nation. We believe these projects provided excellent results and value from the investment of AES funds and have positioned the NH AES well to successfully achieve the goals of its five year POW plan. Each of the following projects contributes to maintaining a sustainable environment.

Key Theme - Air Quality

1. National atmospheric deposition program
   a. Brief description of the activity
   Dogbane and broad leaf aster were studied as ozone-damage indicator species.

   b. Short Impact/Accomplishment Statement
   The use of native plants as bioindicators of ozone injury provided a low cost alternative to air pollution monitoring that is useful at remote sites. In addition, since plants integrate environmental factors, assessment of injury to native plants in situ provides a realistic measure of injury not possible in controlled exposure studies conducted ex situ. However, the relationship between soil moisture and response to atmospheric ozone concentration must be understood to fully realize the effectiveness of plant monitors.

   c. Source of funding/total expenditures/full time equivalents
   Source of funding: Hatch
   Total expenditures: Federal - $6,033
   State- 2,020
   Total-8,053
   Full-time equivalents: Sci 0.2; Total 0.2

   d. Scope of Impact: Multistate Research (CA, CO, FL, GA, IA, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MT, NC, NE, NH, NYC, OH, OR, PA, TX, UT, VA)

2. Tardigrade diversity as a bioindicator of sulfur dioxide pollution
   a. Brief description of the activity
   This study is evaluating the use of lichen health as a measure of sulfur dioxide pollution at study sites in Vermont, New Hampshire and Maine.

   b. Short Impact/Accomplishment Statement
   This study has shown that lichen collected in areas of higher sulfur dioxide concentrations will have an increase in cell membrane permeability and in chlorophyll content. At the same time, the number of tardigrade species was shown to be greatest in sites with the lowest sulfur dioxide concentrations. Accordingly, lichen health and tardigrade diversity can be used as bioindicators in air quality assessments.

   c. Source of funding/total expenditures/full time equivalents
   Source of funding: Hatch
   Total expenditures: Federal - $24,008

State- 10,981
Total - 34,989
Full-time equivalents: Sci 0.4; Total 0.4

d. Scope of Impact: State specific

Key Theme - Biodiversity

1. Genetic diversity of northeastern conifer species
   a. Brief description of the activity
   The geographic distribution of red, black and white spruce has changed greatly since the last glacial maximum. Genetic approaches are being used to determine whether hydridization is a major factor in the evolution of conifers.

   b. Short Impact/Accomplishment Statement
   As climate changes we can expect that the current ranges of various plants will change. This study has documented how two distinct spruce species have hybridized as the range of trees moved North and West since the last Glacial Maximum.

   c. Source of funding/total expenditures/full time equivalents
   Source of funding: McIntire-Stennis
   Total expenditures: Federal - $40,677
   State- 7,002
   Total - 47,679
   Full-time equivalents: Sci. 0.4; Prof 0.4; Total 0.8

   d. Scope of Impact: State Specific

2. Forest management and plant biodiversity
   a. Brief description of the activity
   The impact of major disturbances (e.g., fire, logging) on pitch pine forests is being evaluated at a variety of sites in New Hampshire, with the goal of establishing management plans for preserving ecologically valuable pine barren ecosystems.

   b. Short Impact/Accomplishment Statement
   Pine Barrens ecosystems are threatened in the Northeast. Conservation agencies such as the Nature Conservancy, Society for the Protection of New Hampshire Forests and land managers working for the State of New Hampshire have an urgent need for management plans aimed at preserving these rare communities. The results of this study will be integral to the development and practical implementation of such plans over the next 10 years.

   c. Source of funding/total expenditures/full time equivalents
   Source of funding: McIntire-Stennis
   Total expenditures: Federal - $72,538
   State- 70,882
   Total - 143,420

Full-time equivalents: Sci. 0.6; Prof 0.6; Total 1.2

d. Scope of Impact: State specific

3. Floristic diversity in old growth forests

a. Brief description of the activity

A comprehensive botanical inventory of hardwood old-growth forests is being compiled to provide a baseline for long-term monitoring of important biological reserves and to serve as a basis for comparison between managed and unmanaged forests.

b. Short Impact/Accomplishment Statement

This project is critical to determining the level of biodiversity in New Hampshire's old growth forests to serve as a comparison between managed and unmanaged forests.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	McIntire-Stennis
Total expenditures:	Federal - $12,598
	State- 49,797
	Total - 62,395
Full-time equivalents:	Sci. 0.3, Prof 0.2, Total 0.5

d. Scope of Impact: State specific

4. Predicting range expansion in the Gulf of Maine for introduced species

a. Brief description of the activity

Detailed field studies have been conducted at several sites in the Gulf of Maine and compared with historical data to determine the growth and range of invasive water plant species.

b. Short Impact/Accomplishment Statement

The pattern and mechanisms of introductions of several invasive species are being delineated. In addition, these studies have helped to clarify what the material was in the "green balls" that impacted recreational beaches along our coastline during the past mid-summer, while providing some evidence that some warm temperate species are already being enhanced by global warming.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $12,207
	State- 43,307
	Total - 55,514
Full-time equivalents:	Sci. 0.4; Prof 0.2; Total 0.6

d. Scope of impact: State Specific

5. Biodiversity of aquatic plants

a. Brief description of the activity

The diversity of tropical aquatic and wetland plants was evaluated and summarized in a bilingual field guide, and field studies have begun to compare biodiversity in created and natural wetlands in New Hampshire as a measure of success in mitigation.

b. Short Impact/Accomplishment Statement

This project has demonstrated that the diversity of plants in the aquatic and wetland ecosystems of the tropics are less rich than those in New England, thereby highlighting the importance of conserving such ecosystems in the northeast.

c. Source of funding/total expenditures/full time equivalent

Source of funding: Hatch
Total expenditures: Federal - $11,390
State- 13,077
Total - 24,467
Full-time equivalents: Sci 0.1, Total 0.1

d. Scope of Impact: State specific

Key Theme - Biological Control

1. Endocrine control of reproduction in fish

a. Brief description of the activity

In the Great Lakes and other area lakes, lampreys are considered a major deterrent to fish populations because of the lamprey's parasitic phase in the lake in which it feeds. Sexual maturation of salmonids in seawater netpens also causes economic losses for the commercial aquaculture industry. This effort is investigating the actions of analogs to a brain hormone called gonadotropin-releasing hormone (GnRH) that will eventually be used for sterilizing lampreys and commercially-reared salmon.

b. Short Impact/Accomplishment Statement

A highly specific GnRH-III antibody has been produced that is being used to test various GnRH analogs and can be further used and tested in other biological studies. A new method of sterilization would be very useful in the field of sea lamprey control in the Great Lakes and Lake Champlain. Sterilization of salmonids would benefit the aquaculture industry by allowing fish to maintain the silver bright quality that is highly marketable and by eliminating some of the losses that result from the sexual maturation of males in seawater.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $29,747
State- 24,266
Total - 54,013
Full-time equivalents: Sci. 0.4; Prof. 0.3; Total 0.7

d. Scope of Impact: State Specific

2. Hormonal control of beetle reproduction and rearing characteristics

a. Brief description of the activity

Burying beetles are being studied as a model for investigating the hormonal control of reproduction and reproductive behavior of long-lived beetles with opportunistic or cyclic reproduction. Many beetles with a similar life history (e.g., pine beetles) are pests, and understanding the male and female endocrine pattern may aid in their control.

The specific goal of this research is to understand the role of juvenile hormone (JH) in the regulation of reproduction and reproductive behavior in these insects.

b. Short Impact/Accomplishment Statement

These studies have shown that the juvenile hormone analogue, fenoxycarb, has a negative effect on fecundity and hatching success. Ultimately, the results of this project may yield effective methods to control insects that currently cause millions of dollars of damage each year.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $9,295
State- 54,242
Total - 63,537
Full-time equivalents: Sci 0.4; Prof 0.4; Total 0.8

d. Scope of Impact: State specific

Key Theme - Forest Resource Management

1. Organic matter supply effects on forest soils

a. Brief description of the activity

The effects of organic matter supply on the solution chemistry of a deciduous forest soil were determined by sampling soil solution from zerotension and tension lysimeters in the Harvard Forest DIRT plots.

b. Short Impact/Accomplishment Statement

Fundamental information was determined about controls on soil solution chemistry in forest ecosystems, with an emphasis on how forest ecosystems regulate the production and delivery of dissolved organic carbon and nitrogen to surface waters. Dissolved carbon and nitrogen are important in aquatic nutrient cycles and as contaminants in drinking water supplies.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - $12,303
State- 83,464
Total - 95,767

Full-time equivalents: Sci. 0.2, Prof. 0.4, Total 0.6

d. Scope of Impact: State Specific

2. Role of fungi in forest floor nutrient availability

a. Brief description of the activity

Decay fungi are suspected of transporting certain elements from the mineral soil into decaying wood, thereby replenishing the organic soil as the wood decays. It is also thought that this process occurs only when the decaying wood is at least several inches in diameter. This project is examining the activities of putative basidiomycetous fungi from felled logs and contiguous soil horizions and their role in nutrient availability.

b. Short Impact/Accomplishment Statement

The results of this project are expected to provide information that will be useful in the development of forest management and/or harvesting practices that ensure nutrient availability to sustain continued forest growth.

c. Source of funding/total expenditures/full time equivalents

Source of funding:McIntire-Stennis
Total expenditures: Federal - $13,954
State- 23,053
Total - 37,007
Full-time equivalents: Sci. 0.3; Prof. 0.1; Total 0.4

d. Scope of Impact: State Specific

3. Measuring stocking and structure in N. H. forests

a. Brief description of the activity

Permanent plot measurements and hemispherical photography measurements are being evaluated as methods for conducting efficient inventories and for assessing the effects of management practices on public and privately-owned forest lands.

b. Short Impact/Accomplishment Statement

It is expected that this project will assist foresters in conducting efficient inventories and in evaluating non-timber management objectives on private and public forest lands.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - $37,315
State- 4,231
Total - 41,546
Full-time equivalents: Sci. 0.4, Prof. 0.1, Total 0.5

d. Scope of Impact: State specific

4. Remotely sensed forest vegetation mapping

a. Brief description of the activity
Recreation is an important use of forest resources. Trails through forests provide a valuable component for recreation such as hiking, biking, and snowmobiling. During the past year this project has focused on the development of a methodology for testing if forest vegetation health is adversely affected by trails.

b. Short Impact/Accomplishment Statement
This technique using high spatial resolution imagery and advanced image classification techniques can be used to evaluate trail impacts in any forest. This tool can then be applied by managers to assess and monitor trail impacts over time.

c. Source of funding/total expenditures/full time equivalents
Source of funding: McIntire-Stennis
Total expenditures: Federal - $16,051
State- 83,012
Total - 99,063
Full-time equivalents: Sci. 0.4, Prof. 0.3, Total 0.7

d. Scope of Impact: State specific

5. Genetic control of stress response of trees
a. Brief description of the activity
Polyamine metabolism has been shown to be involved in plant growth, development and stress response. Genetic engineering approaches are being used in this study to investigate polyamine metabolism in plants, using poplar as an experimental model.

b. Short Impact/Accomplishment Statement
A better understanding of plant metabolism should lead to the production of improved varieties of forest trees that are tolerant to various forms of abiotic stress (e.g., salt, drought and aluminum).

c. Source of funding/total expenditures/full time equivalents
Source of funding: McIntire-Stennis
Total expenditures: Federal - $10,626
State- 49,014
Total - 59,640
Full-time equivalents: Sci. 0.3; Prof 0.4; Total 0.7

d. Scope of Impact: State Specific

Key Theme - Water Quality

1. Eelgrass nutrient pollution indicator
a. Brief description of the activity

The goal of this project has been to develop a new robust plant-based indicator, the Nutrient Pollution Indicator (NPI), for the early detection of coastal and estuarine nutrient pollution. A recent focus of this project has been development of an instructional CD-ROM that explains the background and application of the NPI for a management and scientific audience.

b. Short Impact/Accomplishment Statement
The NPI and an accompanying CD-ROM will give coastal managers and scientists information on the nutrient status of coastal waters before obvious eutrophication occurs.

c. Source of funding/total expenditures/full time equivalents
Source of funding: Hatch
Total expenditures: Federal - $9,617
Total - 9,617
Full-time equivalents: Prof 0.1; Total 0.1

d. Scope of Impact: State specific

2. Insect-based water quality statements
a. Brief description of the activity
Generic richness, species richness and the abundance of individuals are being evaluated in relation to surface water quality, especially as influenced by urban runoff and acid waste contamination. These data are being used to develop a species identification manual with tolerance values for use in developing water quality statements.

b. Short Impact/Accomplishment Statement
The key to species will allow individuals studying water quality at sites in New Hampshire to identify the species and to use tolerance values to calculate the biotic index. This will allow rapid and more precise assessment of water quality when using aquatic insects to make statements on water quality.

c. Source of funding: Hatch
Total expenditures: Federal - $41,861
State- 105,604
Total - 147,465
Full-time equivalents: Sci. 1.1; Prof. 0.2; Total 1.3

d. Scope of Impact: State specific

3. Rotavirus and hepatitis A persistence in Class B limed sludge (2 projects)
a. Brief description of the activity
A bench scale model of lime stabilization, as would occur in a treatment plant, is being used to evaluate the effects of a lime stabilizing treatment on the survivability of human pathogens. A second project is aimed at compiling and disseminating data to the public on the survival and long-term outcomes of pathogens deposited into soil through repeated applications of sludge/biosolids.

b. Short Impact/Accomplishment Statement
Acceptance of land applied biosolids, specifically those that are limed, first requires research demonstrating that viruses are inactivated by the liming process. Once this research has been completed, data will be available to either point out problems with land application or to enhance its acceptance. Without such data, there will be continued resistance to land application of biosolids.

c. Source of funding/total expenditures/full time equivalents
Source of funding: Hatch
Total expenditures: Federal - $13,147
State- 6,512
Total - 19,659
Full-time equivalents: Sci 0.4; Prof 0.3; Total 0.7

d. Scope of Impact:
1) State specific
2) Multistate research (MA, NJ, PA, NYC, NH)

4. Application of sewage biosolids to agricultural soils
a. Brief description of the activity
The impact of a soil manufacturing operation based on multiple applications of biosolids at a former gravel site is being assessed for impacts on groundwater quality by sampling water quality in wells installed up slope and downslope of the treatment area.

b. Short Impact/Accomplishment
Results of chemical analyses show an unexpectedly large increase in nitrate concentrations (above drinking water criteria) is some wells in the treatment area, but little or no increase in others. Areas with high nitrate were associated with past stockpiling of sewage sludge on the site. Despite high nitrate levels, no wells have shown any significant increases in trace metal concentrations. These findings have shown that current regulations and permit conditions are not sufficient to protect groundwater quality at sites where repeated application are made. Changes in NH state regulations are underway as a result of this study.

c. Source of funding/total expenditures/full time equivalents
Source of funding: Hatch
Total expenditures: Federal - $7,453
State- 2,358
Total - 9,811
Full-time equivalents: Sci 0.2; Total 0.2

d. Scope of Impact: Multistate research (MA, NJ, PA, NYC, NH)

5. Transport of E. coli in New Hampshire aquifer sediments
a. Brief description of the activity
This project will investigate bacterial depositioning processes in environmentally relevant

porous media, with the goal of providing information that will assist regulatory agencies in establishing guidelines for protecting groundwater supplies for contamination by pathogenic bacteria.

b. Short Impact/Accomplishment
This is a new project, for which results will be presented next year.

c. Source of funding/total expenditures/full time equivalents
Source of funding: Hatch
Total expenditures: Federal - $8,146
State- 7,980
Total - 16,126
Full-time equivalents: Sci 0.4; Prof 0.3; Total 0.7

d. Scope of Impact: State specific

6. Anaerobic cyanobacterial cell maintenance, growth and toxin production
a. Brief description of the activity
This project seeks to enhance understanding of the production, consumption, storage and release of microcystin in lakes, streams and public water supplies.

b. Short Impact/Accomplishment
This is a new project, for which results will be presented next year.

c. Source of funding/total expenditures/full time equivalents
Source of funding: Hatch
Total expenditures: Federal - $11,030
State- 3,946
Total - 14,976
Full-time equivalents: Sci 0.4; Total 0.4

d. Scope of Impact: State specific

Key Theme - Wetlands Restoration and Protection

1. Iron speciation in spodosols and wetland soils
a. Brief description of the activity
This study is providing both laboratory and field techniques for examining iron in soil solutions from perched water tables in soils.

b. Short Impact/Accomplishment Statement
The iron speciation method has revealed that iron stability in forested wetlands is influenced by the formation of iron-organic complexes, as well as by iron reduction in iron-rich subsurface soil horizons. Some iron-rich horizons did not show the classic iron depletion features (gleying) expected in wetland soils, in spite of iron dissolution in June and July. This highlights the need for specific field criteria for identification of wetland conditions in

iron-rich subsurface horizons of forest soils.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $11,021
	State- 42,423
	Total - 53,444
Full-time equivalents:	Sci. 0.2; Total 0.2

d. Scope of Impact: State specific

Key Theme - Wildlife Science and Management

1. White-tail deer energetics

a. Brief description of the activity

Metabolizable energy intake (MEI) was measured in deer and correlated with monthly basal metabolism (BMR), to determine if increased MEI was a factor in the autumnal increase in BMR and associated rapid fat deposition.

b. Short Impact/Accomplishment Statement

Results of this project have shown that the common use of autumnal body weights to assess herd health may not necessarily reflect or yield accurate interpretations of the quality of forest habitat, winter survival of deer, or their productivity.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	McIntire-Stennis
Total expenditures:	Federal - $34,935
	State- 12,117
	Total - 47,052
Full-time equivalents:	Sci. 0.4; Prof 0.6; Total 1. 0

d. Scope of Impact: State Specific

2. Small animal populations and forests

a. Brief description of the activity

Over 800 suitable patches of habitat in Maine, New Hampshire, Vermont and Massachusetts were searched as part of an investigation of landscape features that may be responsible for the dispersal of remnant populations of New England cottontails.

b. Short Impact/Accomplishment Statement

Of the sites examined in Maine, only 9% were occupied by New England cottontails. Other sites were unoccupied (50%) or occupied by snowshoe hares (28%) or Eastern cottontails (13%). Several landscape features were identified that differed between vacant patches and those occupied by New England cottontails. These findings will substantially increase our ability to identify habitats that will enable populations of terrestrial vertebrates to persist as forested habitats are fragmented by human land uses.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - $13,625
State- 89,130
Total - 102,755
Full-time equivalents: Sci. 0.3; Prof 0.1; Total 0.4

d. Scope of Impact: State specific

3. Predation effects on food stream webs

a. Brief description of the activity

This project is investigating the functional role of brook trout as predators and larval two-lined salamanders as predators and prey in forest stream food webs. Preliminary results indicate that the density of larval salamanders is lower in streams with fish, and that larval salamanders reduce daytime surface activity in the presence of trout. Similar data collected in August after trout addition showed that there was a shift in activity from diurnal or aperiodic to nocturnal in streams to which brook trout were added

b. Short Impact/Accomplishment Statement

Macroinvertebrates are used to measure stream and surrounding upland health and integrity. Plethodontid salamanders have been recommended as organisms that can play a similar role in monitoring programs. An increased understanding of how biotic changes such as differences in top predators may alter food web structure will be of value for interpreting the results of stream biomonitoring.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - $40,645
State- 22,919
Total - 63,564
Full-time equivalents: Sci. 0.4; Prof 0.6; Total 1.0

d. Scope of Impact: State specific

Key Theme - Other

1. Developing genetic systems for Frankia

a. Brief description of the activity

The physical properties of the Frankia genome are being investigated to aid in efforts to exploit the potential of this microbial system to provide renewable resources for fuel and to restore previously disrupted environments.

b. Short Impact/Accomplishment Statement

This study has lead to the development of essential genetic tools for this neglected bacterial system. Results suggest that Frankia has potential bioremediation and phytoremediation applications especially on heavy-metal contaminated land.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $27,065
	State- 16,034
	Total - 43,099
Full-time equivalents:	Sci. 0.4, Prof. 0.7, Total 1.1

d. Scope of Impact: State Specific

2. Land ethics

a. Brief description of the activity

This project is gathering information on sustainable agricultural programs at selected land grant universities.

b. Short Impact/Accomplishment Statement

This is a new project, for which results will be submitted next year.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $10,098
	State- 4,556
	Total - 14,654
Full-time equivalents:	Sci. 0.4; Total 0.4

Program Duration

The research projects that contribute to Goal 4 are generally of three to five years duration. All projects are targeted for mid and long term problems.

In fiscal year 2001 the New Hampshire Agricultural Experiment Station had 7.1 full time equivalents of scientist's time assigned to Goal 4. Their research was funded with federal funds from the Hatch, McIntire-Stennis, and Multi-State Research Programs. There were 0 full-time equivalents of technical staff attached to these projects. Professional help in the form of graduate students doing research on these projects amounted to 5.5 students. For this goal, as well as all subsequent goals, there are matching funds from the State of New Hampshire through a budget line within the University of New Hampshire's budget. It is not anticipated that any change in federal funding in the next five years would significantly alter the spectrum of key program components for Goal 4.

Goal 5: Enhanced Economic Opportunity and Quality of Life for Americans
Issue:

Research is necessary to help people improve their economic status in order to improve their perceived quality of life.

Overview:

The New Hampshire AES has established as an output indicator for Goal 5, increased applied and basic research to define the issues that improve quality of life, at what expense, and to improve the chances that rural communities can provide these opportunities.

We will evaluate the outcome indicators of 1) more rural communities capable of providing employment opportunities to their residents, and 2) rural communities better able to adjust and adapt to structural changes in agriculture and forestry so that they remain viable and exciting places in which families may reside. We continue a philosophy that the mission of the Agricultural Experiment Station is consistent with Goal 5 and thus provide support to basic and applied sciences that help posture to maintain enhanced economic opportunity and quality of life for Americans. The NH Agricultural Experiment Station supports the following basic and applied projects within Goal 5 to create technology and research for the benefit of the state, region and nation. We believe these projects provided excellent results and value from the investment of AES funds and have positioned the NH AES well to successfully achieve the goals of its five year POW plan. Each of the following projects contributes to maintaining economic opportunity and quality of life.

Key Theme - Community Development

1. Improvement of rural and agricultural sample survey methods

a. Brief description of the activity

Four additional questionnaires were developed and administered to provide information useful to the agricultural industries and to communities in the Northeast, while adding to our understanding of the impact of personalization on survey response rates and response bias.

b. Short Impact/Accomplishment Statement

This project has 1) assisted the Maryland Department of Natural Resources develop a forest management plan for the City of Baltimore Reservoirs, 2) assisted a Board of Selectmen in assigning priorities to specific development options within their community, 3) designed and evaluated specific metrics assessing a cooperative research program between commercial fishermen and scientists, and 4) assisted a state agency in developing a comprehensive outdoor recreation plan for the State of New Hampshire. These studies have also educated decision-makers about the importance of methodological research, and havecontributed to the development of Western Regional Coordinating Committee WCC-1001.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $7,899
	State- 44,218
	Total - 52,117

Full-time equivalents: Prof. 0.4; Total 0.4

d. Scope of Impact: Multistate Research (CA, CO, GA, IA, KY, MA, ME, MI, ND, NH, NV, NY, OH, OR, PA, TX, UT, WA, WVA, WY)

2. Rural economic development alternatives in the northeast (3 projects)

a. Brief description of the activity

One project focused on the growing shortage of affordable rental and owner-occupied housing in Eastern MA, Southern N.H. and Maine, which has become a major concern of area business leaders and advocates for housing for the low-income population. This research investigated alternatives for providing additional affordable workforce housing and involved the development of several budget case scenarios for housing development. The second project is assessing the economic impact of a once dominant pulp and paper industry in chiefly rural, Coos County, New Hampshire, while the third extended that work with a focus on the impact of the pulp industry decline on the public's access to health care.

b. Short Impact/Accomplishment Statement

In addressing the affordable housing issue, local municipal planning boards, real estate developers, and housing providers will benefit from information on the expected economic and financial consequences of alternative land use and affordable housing strategies. Similarly, state, regional and local town officials dealing with issues of economic development can use the impact model as a basis of analysis. The quantification of inter-industry relationships and multipliers provide insight into the primary and secondary effects of growth via a particular plant or sector. Knowledge of these effects should help guide officials as they weigh incentive packages to entice a firm's location decision. This research is also expected to provide a better understanding of health care problems in rural NH, and evaluation of alternative policies that could be implemented to improve the situation.

c. Source of funding/total expenditures/full time equivalents

Source of funding:	Hatch
Total expenditures:	Federal - $13,278
	State- 113,646
	Total - 126,924
Full-time equivalents:	Sci 0.4; Prof 0.2; Total 0.6

d. Scope of Impact: Multistate research (VA, WI, PA, NYC, KY, NV, DE, WA, UT, NH, IA, IL, OH, GA, RI, ND, IN, MN, NC, CO, OR)

3. Transborder forestry relations

a. Brief description of the activity

This project is assessing community dependence on forest resources in northern New England and adjacent areas in Canada.

b. Short Impact/Accomplishment Statement

This research has identified the Forest Reliance Index (FRI) as a powerful measure of dependency that is easily understood by landowners, auditors, stakeholders and the public. It

is expected that the FRI and highly correlated socio-economic indicators will be included in sustainable forestry certification protocols.

c. Source of funding/total expenditures/full time equivalents

Source of funding: McIntire-Stennis
Total expenditures: Federal - $5,898
State- 84,779
Total - 90,677
Full-time equivalents: Sci. 0.4, Prof. 0.4, Total 0.8

d. Scope of Impact: State Specific

4. Economic considerations in municipal solid waste disposal

a. Brief description of the activity

A data set has been compiled for 200 NH towns and is being used to determine the effects of unit-based pricing of solid household waste on property tax rates, waste production, and total waste management costs

b. Short Impact/Accomplishment Statement

It is hoped that the unbundling of services that are occurring in local governments through privatization will result in reduced cost of service delivery. While unit pricing of household waste is generally still handled by local governments, it is a departure from traditional financing methods. The results of this study will shed light on some potential savings from the unbundling of municipal services.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $24,246
State- 49,781
Total - 74,027
Full-time equivalents: Sci. 0.4; Prof 0.5; Total 0.9

d. Scope of Impact: State specific

5. Benefits and costs of resource policies

a. Brief description of the activity

A biosolids survey was sent to 500 property owners in one N.H. community, in which biosolids are being applied to agricultural land, to assess the public's awareness of the costs and benefits of this practice.

b. Short Impact/Accomplishment Statement

Survey results showed that residents became less supportive of land application of biosolids as the volume of information presented by the media increased. These findings highlight the need for a sound educational program based on information that explicitly outlines the economic benefits and negative impacts that typically occur with the use of land application.

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal - $35,114
State- 19,299
Total - 54,413
Full-time equivalents: Sci. 0.4, Total 0.4

d. Scope of Impact: Multistate research (CA-A, CA-B, CO, GA, IA, KY, MA, ME, MI, ND, NH, NV, NYC, PA, TX, OH, OR, UT, WA, WVA, WY)

6. Welfare reform and the well-being of rural low-income families

a. Brief description of the activity

This effort tracked over time the individual and family circumstances, functioning and well-being of rural low-income families with children in the context of welfare reform.

b. Short Impact/Accomplishment Statement

The NC223 team has been awarded two USDA-NRI grants totaling almost $250,000 to further the work begun under this project. The Rural Families Speak website has been developed and serves as a dynamic site allowing researchers to share the latest findings and to link to other studies and work that complement the understanding of rural families in the context of changing welfare policies. A profile of NH rural families is posted on the site (http://www.ruralfamilies.umn.edu).

c. Source of funding/total expenditures/full time equivalents

Source of funding: Hatch
Total expenditures: Federal $7,830
Total 7,830
Full-time equivalents: Total 0.0

d. Scope of Impact: Multistate; Integrated Research and Extension (IN, MD, MN, OH, CA, CO, KY, LA, MA, NE, NH, OR)

Program Duration

The research projects that contribute to this goal are generally of three to five years duration. All projects are targeted for mid and long term problems.

In fiscal year 2002 the New Hampshire Agricultural Experiment Station had 1.6 full time equivalents of scientist's time assigned to Goal 5. Their research was funded with federal funds from the Hatch, McIntire-Stennis, and Multi-State Research Programs. There were 0 full-time equivalents of technical staff attached to these projects. Professional help in the form of graduate students doing research on these projects amounted to 1.5 students. For this goal, there were matching funds from the State of New Hampshire through a budget line within the University of New Hampshire's budget. It is not anticipated that any change in federal funding in the next five years would significantly alter the spectrum of key program components for Goal 5.

B. Stakeholder Input

For some time, the AES had maintained a list of stakeholders from whom we attempted to seek input. However, the response from these stakeholders had not been sufficient. Therefore, we have now developed a N. H. Agricultural Experiment Station Advisory Committee, comprised of the following members:

Deanna Howard
Dartmouth-Hitchcock Medical Center

Edith Tucker
The Coos County Democrat

Sharon Francis
Connecticut River Joint Commission

Hal Bodwell
Dairy producer

Anne Sprague
Edgewater Farm

Barry Kelley
Forest industry

Bruce Clement
UNH Cooperative Extension

John McLean
UNH Farm Manager

Peter Lamb
New Hampshire Charitable Foundation

Nancy Berliner
N. H. Rural Development Council

Dean Moreau
Yankee Farm Credit

Jeff Huntington
Pleasant View Gardens

David Babson
N. H. State Representative

Jeanie McIntyre
Upper Valley Land Trust

Tom Kelly
UNH Sustainability Program

Chris Streeter
Blue Seal Feeds, N. H. CARET representative

Our first meeting with this group occurred in December of 2002. That session was largely informational, and devoted to familiarizing the membership with the history of the AES system and its mission and goals, our organizational structure, our farms and research facilities, funding mechanisms and levels, and an overview of current research projects. One of our researchers also described his efforts to identify our stakeholders, in advance of surveys he will conduct to better assess stakeholder awareness of the AES, to determine the most effective methods for disseminating results of our research to end users, and to assess our future progress in improving our overall effectiveness. Our second meeting with this committee has been scheduled for May of this year.

Other efforts to reach and interact with a cross-section of stakeholders include the following:

1. Two publications targeted largely to stakeholders have been produced and each sent to an audience of approximately 10,000 per issue. These publications include two issues (twice yearly) of "INSIGHTS", which address events, people and contributions from the College of Life Sciences and Agriculture and the NH AES. Comments and opinions back to the NH AES and the College are encouraged. A separate issue of "Research Highlights" exhibits the contributions and impacts of research sponsored by the NH AES and the College of Life Sciences and Agriculture. Comments and opinions back to the NH AES are encouraged.

2. We continue to use a Research Advisory Committee to assist the Agricultural Experiment Station administration in the review of AES proposals and to recommend research areas of State and regional importance to which the AES should pay particular attention.

3. The Director of the NH AES has participated with the State of NH Agricultural Advisory committee to inform them of NH AES activities and to request input.

4. The Director of the NH AES served on the NH Current Use Board and attended community fact-finding meetings as well as serving on the State Conservation committee to get stakeholder input.

5. The NH AES has been a participant several State Fairs and at the NH Farm and Forest Exposition. These interactions allow direct stakeholder input.

6. The Director of the NH AES attended meetings with NH Vegetable Growers, the Farm Bureau, and representatives of the NH Horticulture Association.

7. Representatives of the NH AES have visited NH farms, orchards, greenhouses and extension twilight meetings to speak directly with constituents.

8. The Associate Director attended the annual N.H. Farm Bureau meeting and Farm and Forest Exposition.

B. Statement of the process used to identify stakeholders and collect input.

During the 2001-2002 fiscal year, a Steering Committee was formed to assist us by developing a list of potential AES Advisory Committee members, whom we in turn invited to participate. The Steering Committee itself was comprised of Stephen Taylor, N. H. Commissioner of Agriculture; Nancy Berliner, Executive Director of the N. H. Rural Development Council; Donald Sundberg, UNH Vice President for Research and Public Service; and Lorraine Merrill, journalist, dairy producer and University System of N. H. Trustee. We have begun and will continue to meet about twice per year with the Advisory Committee to exchange ideas for making this station most effective in serving stakeholders and the citizens of our state. We expect that other, regular means of communication will be implemented as this

new initiative progresses.

In addition to the interaction with our Advisory Committee, the NH AES sends INSIGHT and Research Highlights publications to citizens of the state and region requesting input on research areas, concerns and needs. The NH AES and the College of Agriculture attend state and regional fairs and expositions with a prepared display to meet stakeholders, distribute information and obtain input. The NH AES Administrators present talks at various grower group meetings, as well as the Grange and Farm Bureau, to meet stakeholders and obtain input. The AES Administrators and others working with the NH AES visit state and regional farms, orchards, greenhouses, and extension meetings to assess needs and collect input. The AES Administrators frequently travel to different counties with Extension Specialists to obtain input on integrated needs.

C. Statement of how collected information was considered.

Information from a variety of stakeholder sources has been incorporated into AES policy. Concerns over AES-funded projects that might better serve the needs of the state and region led to a change in the criteria for evaluating AES program proposals. A statement is now required, explaining how the project will impact state and/or regional needs. Concerns over limited support for horticulture, the fastest growing area of the NH agricultural economy, and concerns for water quality have led to targeted funding from the AES for projects in horticulture and water quality. Concerns over non-balanced information with which to make informed decisions on plant biotechnology and genetically engineered foods led to an AES-sponsored Public Forum on Genetically Modified Foods. In addition to our expanded efforts to identify and engage stakeholders, the NH-AES has begun efforts to have a survey instrument developed to assess the needs of a larger population of stakeholders. The AES is sponsoring (with preparation through the Department of Resource Economics at UNH) the creation of a survey instrument and the survey of New Hampshire citizens to obtain input on the needs and results of AES projects as defined by the five national goals. Additionally, we established the Advisory Committee that will now assist the AES in identifying important current and emerging needs, and to advise the AES on matters such as preferred mechanisms for achieving the timely delivery of research findings to end users.

C. Program Review Process

The New Hampshire Agricultural Experiment Station has had a peer review process for projects for over fifteen years. The proposal-process applies to all Goals and is as follows. Each August a letter is sent to all faculty in the College of Life Sciences and Agriculture and to Deans of other Colleges that there will be a competition for Hatch and McIntire Stennis funds. Faculty must submit a one page description of the project they are interested in performing. They meet with the AES Associate Director to discuss the project and a decision is made as to whether this can be supported with either of these two funds, does it fit within the guidelines for them. If so, the faculty member develops a full proposal using the CSREES/USDA format. Faculty must also suggest five or six potential external (non-UNH) peer reviewers. From this list the Associate Director obtains at least two anonymous reviews. The reviews are given to the faculty member and they have the opportunity to revise the proposal or rebut the reviewer's comments if they wish. The next step in the review process is an evaluation of priority for funding projects. This is

performed by an internal committee of five or six faculty members who are experienced in research. All proposals are reviewed, taking into account the external reviewer's evaluations and the faculty member's response. From this they make a recommendation for priority for submission to USDA for approval. The AES Administrators use this recommendation and their own evaluation to make the final decision as to which projects will be funded with Experiment Station funds. Usually about 80% of the proposals submitted are forwarded to CSREES/USDA for their approval for funding. We will continue this process in New Hampshire. However, we have modified it to utilize the results of stakeholders input. When the call for proposals is sent out each year, it now includes guidelines of the criteria used for internal proposal evaluation. These criteria include, along with research quality and potential, 1) how the proposal addresses state, regional and stakeholder issues, 2) the quality of the prior year progress report, and 3) outcomes (including publications and grant submissions) from the work performed.

D. Evaluation of the Success of Multi and Joint Activities

1. Did the planned programs address the critical issues of strategic importance.

Below is listed the topic areas in which the NH AES is involved with multi-state and joint activities that are planned programs listed in our POW. Each area and project addresses a critical area of strategic importance as described by its placement within the list of the five national goals above.

- Genomic basis for resistance to avian diseases
- Improved supply of nutrients to dairy cows
- Predicting bovine fertility
- Improving nutrition for dairy calves
- Genetics and breeding of Cucurbita
- Strawberry production in modified environments
- Genetic improvement of tilapia for aquaculture
- Assessing the nutritional risk of the elderly
- National atmospheric deposition program
- Engineering greenhouses for horticultural plant growth
- Rural economic development alternatives in the northeast
- Public policies and food system performance
- Benefits and costs in natural resource planning
- Economic considerations for municipal solid waste disposal
- Welfare reform and the well-being of rural low-income families

Many of these projects originated as the result of stakeholder input and continue to address stakeholder needs.

2. Did the planned programs address the needs of under-served and under-represented populations.

While not all of the multistate and joint projects were designed to serve the under-represented and under-served populations, most of the projects in the multistate list above do, in fact, directly

serve under-represented and under-served populations. These include the poor, the homeless, small communities with less than adequate resources and representation, families in rural areas, the elderly, the undernourished, those seeking self-sufficiency, and farmers seeking new crops or replacement crops for species with failing sales, among others.

3. Did the planned programs describe the expected outcomes and impacts.

Individual projects are at different stages of maturity and have exhibited different levels of impact. Each multistate and joint project, in our opinion, has been a good investment of federal and state funds, resulting in continuing progress and benefits to the people of the state and region. Some examples of the outcomes and impacts derived from these projects may be seen below.

- Poultry health will be improved by greater understanding of the genes that affect avian immunity. Improved health represents a substantial economic benefit to poultry breeders and producers

- Ruminally protected amino acids can lead to increased milk protein and more efficient utilization of dietary protein, thereby reducing levels of nitrogen excretion in dairy manure.

- In lactating dairy cattle, estrous cycles during the postpartum period that consist of three waves of follicular growth preceding insemination appeared to be conducive to improved fertility. If the incidence of follicular wave pattern in cattle is determined genetically, this will impact future selection strategies used to identify genetically superior individuals and to enhance fertility.

- Lactoferrin supplementation improved performance of young calves through increased growth and profitability by earlier weaning. Lactoferrin may prove to be an adequate means of reducing disease incidence without using antibiotics in neonatal calves.

- Commercial production of "Snackjack" hull-less pumpkin seeds as a new, nutritious snack food offers a new crop opportunity for farmers, a new sales opportunity for retailers and a new choice of healthy snack food for consumers. Newly obtained information on pumpkin stem maturity, strength and storage life will assist growers in knowing when to harvest pumpkins and will be useful to breeders in evaluating breeding lines for good fruiting stem quality.

- Growers are adopting new systems to produce strawberries for the early market and as an alternative production system that is less pesticide intensive. These systems also reduce non-productive, vegetative growth in field grown strawberry production.

- Vegetable-derived antioxidants originating from dietary carotenoids appear to decrease risk of aging-related eye disease. Dietary modification may help alleviate the cost of eye disease and improve quality of life.

- Work is under way to improve greenhouse lighting designs, and to determine the economic returns from alternative lighting systems.

- An inventory of knowledge regarding measurement and non-response error in surveys has been collected. This knowledge has educated numerous policy makers, local leaders and resource managers on the potential threats to accuracy of surveys.

- Information was generated to assess the effect of unit pricing on waste production and recycling within communities.

- Data indicate that the rural poor in New Hampshire have problems finding child care, finding employment that pays a living wage and maintaining their access to transportation.

- Hatch related research of two NH AES investigators resulted in receipt of a large IFAFS grant to study factors affecting carotenoid levels in plants and the effect of carotenoids on vision

- The Hatch related research of one NH AES scientist provided the basis for new and substantially revised NRC guidelines on the protein and amino acid requirements of dairy cattle

4. Did the planned programs result in improved effectiveness and/or efficiency.

Multistate research has allowed NH to leverage the results it gets for the funds it expends. We have experienced a decrease in duplication of efforts between states, and an increase in communication and coordination. Multistate research expenditures appear currently to be the best use of money (based on project return for dollars invested) of any of the projects in the NH AES portfolio of AES-sponsored research. Further efficiency has been realized with efforts to improve our integrated research. Because the NH AES and NH-Extension do not report to the University along the same reporting lines, communication between the AES and Extension had become poor. Efforts to improve integrated research has reopened the lines of communication and provided the opportunity for effective integrated efforts.

E. Multistate Extension Activities

This section is not applicable to the NH-AES

F. Integrated Research and Extension Activities

From the table of integrated projects below, one may see that the NH AES spent $**371,261** of a combined Federal allocation for Hatch and Multistate of **$1,380,145.** This represents a **27%**

integrated portfolio, in excess of the 20% agreed to for FY 2000. Pertinent information is included in the table below. A brief description of the progress to date on each planned activity follows the table.

Integrated Projects

Name	Project Number	Project description	FY 2002	
Schwab Charles	H-366	Metabolic Relationships in supply of Nutrients for lactating cows	Federal $	60,444
	H-368	Management systems for improved decision making and profitablity of dairy herds	Federal $	56,964
Loy J. Brent	H-387	Conservation and utilization of plant genetic resources	Federal $	10,450
	H-074	Genetics and breeding of cucurbits	Federal $	60,078
Lord William	H-383	Intensive Production of strawberries	Federal $	30,236
	H-375	Multidisciplinary evaluation of new apple cultivars	Federal $	1,724
Erickson Peter	H-395	Management systems for improved decision making and profitability of dairy herds	Federal $	15,501
Fisher Paul	H-394	A decision-support system for control of pH in soilless container media	Federal $	36,422
	H-396	Decision support for design and control of plant growth systems	Federal $	11,472
Knight Suzann	H-402	Rural low-income families: tracking their well-being and functioning in the context of welfare reform	Federal $	7,830
Neal Cathy	H-413	Nutrient management for production and maintenance of ornamental plants	Federal $	14,330
Stephan Seiter	H-419	Nutrient management on organic farms	Federal $	8,166
Alberto Manalo	H-315	Private strategies, public policies and food systems	Federal $	34,554
	H-419	Rural economic development alternatives	Federal $	2,995
Assessments			$	20,095
TOTAL			$	**371,261**

Integrated Project Descriptions

Schwab, Charles H-366 Metabolic relationships in supply of nutrients for lactating cows

This study has focused on ruminally-protected amino acids to enhance protein utilization, to increase milk protein and to decrease nitrogen excretion. When these findings are applied

in diet formulation, increases in conversion of feed nitrogen to milk protein of 20% or more have been reported.

Schwab, Charles H-368 Management systems for profitability of dairy herds

This study has better defined protein requirements and feeding strategies for increasing efficiencies of gain, feed conversion to weight and lowered feed costs from birth to first lactation.

Loy, Brent H-387 /H-074 Conservation and utilization of plant genetic resources

These programs have resulted in the development and release of several hull-less seed hybrids, and the commercial production of "Snackjack" hull-less pumpkin seeds as a new, nutritious snack food.

Lord, William H-383 Intensive production of strawberries

Grower are adopting these systems to produce strawberries for the early market and as an alternative production system that is less pesticide intensive. These systems also reduce non-productive, vegetative growth in field grown strawberry production.

Lord, William H-375 Multidisciplinary evaluation of new apple cultivars

The shift of the New Hampshire apple industry from a wholesale market orientation to a retail market orientation requires that growers offer consumers unique and exceptional varieties. Numerous cultivars have been evaluated, and several of the more promising have now been chosen by growers for commercial testing.

Erickson, Peter H-395 Management systems for improved decision making and profitability of dairy herds

Lactoferrin supplementation was found to improve performance of young calves through increased growth and profitability by earlier weaning. Lactoferrin may be effective in reducing disease incidence without the use of antibiotics in neonatal calves.

Fisher, Paul H-394 A decision support system for control of pH in soilless container

This project has provided directly-applicable information for industry on how to group plants according to iron efficiency, how to raise medium-pH using flowable lime or potassium bicarbonate, and use of iron chelate drenches to correct pH problems. By correctly managing micronutrient levels and pH, NPK loading can be reduced in greenhouses, because growers often over-supply complete, blended fertilizer in order to supply sufficient micronutrients.

Fisher, Paul — H-396 Decision support for design and control of plant growth systems

Investigations are providing information that will generate improved greenhouse lighting designs and associated cost-benefit relationships of the various lighting alternatives.

Knight, Suzann — H-402 Rural low-income families: tracking their well-being and functioning in the context of welfare reform

This project is tracking the welfare of rural low-income families in the context of welfare reform, and making information available to rural communities and policy decision-makers

Neal, Cathy — H-413 Nutrient management for production and maintenance of ornamental shrubs

Development of fertilizer recommendations for trees and shrubs in production nurseries, and later in landscape situations, will result from these trials. Nutrient use and efficiency are economically and environmentally important.

Seiter, Stephan — H-419 Nutrient management for organic farms

This project seeks to improve nutrient management on farms that use organic soil amendments as a fertility source and to determine environmentally sound cropping practices for forage soybeans.

Manalo, Alberto — H-315 Private strategies, public policies and food systems

These studies help food processors and farmers in New Hampshire improve their marketing strategies and practices. The studies also have raised New Hampshire citizens' awareness of the importance and contributions of agriculture and the food processing industry in the state.

Manalo, Alberto — H-423 Rural economic development alternatives in the NE.

Addressing affordable housing issues, this project helps local municipal planning boards, real estate developers, and housing providers by providing information on expected economic and financial consequences of alternative land use and affordable housing strategies. Knowledge of these effects will help guide officials as they weigh local growth decisions.